# Phase-Differentiated Black Hole Cosmology: A Framework for Nested Universes, Variable Constants, Lensing-Induced Phase Variation, and CPT-Generalized Horizon Transitions

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**Abstract**

We propose a cosmological framework in which black hole horizons function as phase-transition boundaries between causally isolated universes. Extending CPT-symmetric cosmology (Boyle, Finn & Turok 2018) and Cosmological Natural Selection (Smolin 1992), we argue that the phase relationship imposed at a horizon need not be a strict CPT reversal, but may vary continuously as a function of black hole parameters — mass, spin, and charge. This generalization implies that child universes inherit not fixed physical constants but phase-dependent constants, with no privileged scale. The observable universe is reframed as the interior of a black hole whose horizon imposed a specific phase shift on a parent-universe vacuum, explaining the apparent fine-tuning of constants as geometric inheritance rather than anthropic selection. We further propose that gravitational lensing and frame-dragging produce spatially non-uniform phase shifts across a single horizon surface, such that one black hole can simultaneously mediate multiple local phase relationships. This horizon phase variation imprints as large-scale anisotropy in the child universe — offering a candidate explanation for the observed hemispherical power asymmetry in the CMB. Hawking radiation encodes the phase-conjugate signature of infalling matter, constituting the symmetry-required exit, with the final evaporation burst representing the complete readout of the black hole's accumulated interior history. The framework implies no privileged beginning.

## 1. Introduction

The standard cosmological model offers no account of why the fundamental constants take the values they do, why the Big Bang occurred at all, or why the CMB exhibits large-scale anisotropies that resist clean inflationary explanation. Anthropic selection arguments are logically consistent but explanatorily inert. Smolin's Cosmological Natural Selection proposed black hole formation events seed child universes with mutated constants, yielding a Darwinian landscape. Boyle, Finn and Turok proposed that the Big Bang produced two CPT-conjugate universes, together forming a globally CPT-symmetric system invisible to each other by

construction.

The framework presented here synthesises and extends both proposals with four principal claims: (1) black hole horizons are generalised phase boundaries between causally isolated universes; (2) the phase relationship at each horizon is a continuous function of horizon geometry, not restricted to CPT reversal; (3) physical constants in child universes are determined by that phase shift, not inherited with random mutation; and (4) gravitational lensing and frame-dragging produce spatially varying phase shifts across a single horizon, imprinting structure in the child universe that may be observable as CMB anisotropy.

## 2. The Horizon as Generalised Phase Boundary

The maximally extended Schwarzschild solution in Kruskal-Szekeres coordinates contains four spacetime regions: two exterior regions, a black hole interior, and a white hole interior. The white hole — thermodynamically disfavoured — is precisely what phase-reversal symmetry demands: if matter transits inward, its conjugate must exit somewhere. We resolve the apparent absence of white holes by noting that they exist but are phase-shifted out of observational reach. They are not missing — they are in the conjugate phase.

We define a generalised phase operator Φ acting on quantum fields at the horizon. In the Boyle-Turok model, Φ = CPT exactly. We propose instead:

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Phi(M, J, Q) = C^alpha * P^beta * T^gamma
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where M, J, Q are black hole mass, angular momentum, and charge respectively, and alpha, beta, gamma are continuous parameters determined by horizon geometry. Pure CPT reversal is the special case alpha = beta = gamma = 1. A Kerr black hole (J not equal to 0) has a ring singularity and an extended Penrose diagram with additional interior regions, suggesting a genuinely distinct phase relationship from the Schwarzschild case. Different black holes are different kinds of door.

## 3. Variable Constants as Phase Inheritance

If physical constants in a child universe are determined by Φ, and Φ varies with black hole parameters, then different black holes produce child universes with different constants. This includes the speed of light c, treated here not as a universal invariant but as a phase-dependent parameter of each universe's local vacuum structure. Scale itself — the relationship between length, time, and energy — is set by the phase shift at the originating horizon. There is no privileged scale across the full ensemble.

This resolves the fine-tuning problem without anthropic selection. Our constants are what they are because our universe was born from a black hole that imposed a specific Φ. The question 'why these constants?' becomes 'what were the parameters of our parent black hole?' — answerable in principle if the mapping Φ(M,J,Q) → {c, h-bar, G, alpha...} can be derived. That derivation is the central open theoretical programme implied by this framework.

## 4. Hawking Radiation as the Phase-Conjugate Exit

A phase-reversal model demands that if matter enters at the horizon, its phase conjugate must exit. Hawking radiation satisfies this requirement. In the standard derivation, virtual particle pairs near the horizon result in one particle escaping and one falling inward. The escaping particle is the CPT conjugate of the infalling partner in the quantum field theoretic sense. Under the generalised Φ(M,J,Q), the escaping radiation is the phase-conjugate emission corresponding to whatever shift the specific horizon imposes.

This reframes the information paradox. Information is not destroyed — it is phase-shifted. The outgoing radiation encodes the complete state of infalling matter in the conjugate phase. It appears thermal and information-free to observers in the original phase because they lack the conjugate detector required to decode it. The paradox dissolves as a measurement problem rather than a physical one.

## 5. Time Dilation, Emission Rate, and the Final Burst

If the phase-conjugate exit exists, why do we measure only vanishingly small Hawking emission from astrophysical black holes? The answer lies in the causal structure of the horizon. From any external reference frame, time dilation at the event horizon is formally infinite — infalling matter freezes and redshifts asymptotically. The speed of light, as the invariant defining the causal structure of spacetime, is directly responsible for this dilation relationship. The emission rate is set by the ratio of the black hole's proper time to our coordinate time — producing Hawking temperatures of order 10^-8 Kelvin for stellar mass black holes, far below any detectable threshold.

Hawking evaporation accelerates as mass decreases, culminating in a final burst as the remaining mass converts entirely to radiation. In this framework that final burst is not featureless thermal noise — it is the complete phase-conjugate readout of everything the black hole ever absorbed. The entire accumulated history of that cosmic interior, emitted in a single event. The black hole does not die. It finishes translating.

## 6. Gravitational Lensing, Frame-Dragging, and Horizon Phase Variation

The phase operator Φ has been treated above as a global property of the horizon, determined by the black hole's bulk parameters M, J, Q. We now relax this assumption. Gravitational lensing distorts the spacetime geometry locally around any massive object. Near a black hole, this effect is extreme: the photon sphere, frame-dragging in Kerr geometry, and infalling matter distributions all produce a horizon surface whose local curvature is non-uniform. Different null geodesics arriving at different horizon regions have traversed different curvature histories.

If Φ is sensitive to local horizon geometry — as the dependence on J already suggests — then different regions of the same horizon surface impose different local phase shifts simultaneously. A single black hole is not a single door but a surface of continuously varying

phase windows, each mediating a slightly different relationship between the parent universe and the child.

The consequence for the child universe is direct. The phase variation across the birth horizon imprints as spatial variation in physical constants — or more precisely, as variation in the vacuum structure — across the child universe's initial conditions. The pattern is not random: in a Kerr black hole, frame-dragging breaks the spherical symmetry of the horizon in a structured, spin-axis-dependent way. Prograde and retrograde orbits experience different effective geometries, producing a phase asymmetry that is oriented relative to the spin axis.

This spin-induced horizon phase asymmetry propagates into the child universe as a preferred spatial direction — a large-scale anisotropy in the initial conditions that would persist into the CMB.

> **Connection to the CMB hemispherical power asymmetry.** Observations of the CMB reveal a statistically significant asymmetry in power between hemispheres — one half of the sky consistently shows slightly more structure than the other. This hemispherical power asymmetry has been confirmed across multiple analyses of WMAP and Planck data and remains unexplained within standard inflationary cosmology, which predicts statistically isotropic initial conditions. The spin-dependent phase variation at the parent horizon proposed here is a natural candidate for the origin of this asymmetry. The preferred axis of the CMB asymmetry would correspond to the projection of the parent black hole's spin axis onto our sky. This constitutes a specific, falsifiable prediction: if the framework is correct, the CMB asymmetry axis should align with other large-scale directional anomalies in the CMB — the so-called 'axis of evil' — which has itself been noted but not explained.

## 7. Self-Similar Nesting and the Dissolution of First Cause

The framework is self-similar by construction. Our universe is the interior of a black hole in a parent universe. The black holes our universe contains are birth events of child universes. There is no ground level and no privileged scale at which the nesting terminates, consistent with scale relativity (Nottale 1993). The observable universe contains an estimated 10^17 to 10^18 stellar mass black holes — each a potential universe, each containing comparable populations of its own.

Time is local to each universe, set by its phase-shift-determined vacuum parameters. There is no global time across the nesting within which a first event could occur. The Big Bang was an ordinary gravitational collapse in a parent universe — not a unique or singular event requiring special explanation, but one of an enormous recurring population. The question of first cause is not answered but dissolved: it assumed a container with a temporal axis that the recursive structure does not provide.

## 8. Predictions

**8.1** Black hole parameters should correlate with child universe constants in a structured, non-random way. A derivable mapping $\Phi(M,J,Q) \rightarrow$ {c, h-bar, G, alpha...} would constitute a predictive theory of constants.

**8.2** Hawking radiation from black holes of different spin should differ in subtle quantum correlations beyond the thermal spectrum, reflecting the different phase operators at Kerr versus Schwarzschild horizons.

**8.3** The Big Bang should exhibit CPT-like symmetry in its initial conditions, consistent with Boyle-Turok, but with phase parameters determined by parent black hole geometry rather than exact CPT reversal.

**8.4** The final evaporation burst of any black hole should carry non-thermal correlations encoding its phase-conjugate interior history. Detection of such structure in primordial micro-black-hole evaporation would constitute direct evidence.

**8.5** The CMB hemispherical power asymmetry should align with the spin axis of the parent black hole. Concretely, the asymmetry axis should coincide with other large-scale CMB directional anomalies. This is testable against existing Planck data without new observations.

## 9. Conclusion

We have outlined a framework in which black hole horizons are generalised phase boundaries whose shift operator varies continuously with horizon geometry; physical constants are determined by that shift at each universe's birth; Hawking radiation is the phase-conjugate exit required by symmetry; gravitational lensing and frame-dragging produce spatially non-uniform phase shifts across a single horizon, imprinting large-scale structure in the child universe; and the CMB hemispherical power asymmetry is a candidate observational signature of this mechanism. The framework dissolves fine-tuning through geometric inheritance, the information paradox through phase-encoding, and first cause through recursive structure.

The primary open theoretical programme is the derivation of the explicit mapping $\Phi(M,J,Q) \rightarrow$ physical constants from first principles. The primary observational programme is the alignment analysis of CMB directional anomalies against predictions of spin-induced horizon phase asymmetry — a test executable against existing data.

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> *Revision notes (v0.2 → v0.3): Added Section 6 on gravitational lensing and frame-dragging as mechanisms producing spatially non-uniform phase shifts across a single horizon surface. Introduced the CMB hemispherical power asymmetry as a specific falsifiable prediction (Prediction 8.5). Updated title, abstract, introduction, and conclusion accordingly. This version contains the first observationally testable prediction against existing data.*

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